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RECENT LITERATURE

Grinnell, Joseph. A GEOGRAPHICAL STUDY OF THE KANGAROO RATS OF CALIFORNIA. University of California Publications in Zoology, vol. 24, no. 1, pp. 1-124, pls. 1-7, text figures 1-24. June 17, 1922.

Grinnell's "Geographical Study of the Kangaroo Rats of California" presented with a wealth of pertinent detail is not only a valuable contribution to our knowledge of an exceedingly interesting and imperfectly known group of rodents, but has an important bearing in a wider field as well. The main purpose of the work as stated by the author has been "to ascertain the degree of correlation which exists between speciation and geography and environment," and perhaps no better group of mammals, owing to its plasticity, or a better area, due to highly diversified environmental conditions, could have been chosen.

The author's conclusions are based upon a study of 2,834 specimens from California, of which 2,212 skins with skulls, representing 213 localities, are in the Museum of Vertebrate Zoology, University of California. Four hundred and nine specimens of kangaroo rats in the collection of the Biological Survey, United States Department of Agriculture, representing species and localities deemed of special importance by the author, were shipped from Washington, D. C., and material was made available by other institutions.

Thirty-three species and subspecies of kangaroo rats are recognized as ranging within the State of California, "as many forms as occur all told outside of this State and at the same time do not reach into it." These are assigned to the Heermanni, Ordii, Merriami, Agilis, Microps, and Deserti groups, the group names being those of typical included species.

Until Doctor Grinnell began his work upon the kangaroo rats, three generally accepted genera, *Dipodomys*, *Perodipus*, and *Microdipodops*, were assigned to the subfamily Dipodomysinae. The generic separation of *Dipodomys* and *Perodipus* rested upon the supposed constancy of a differential number of complete digits on the hind foot. The author, however, has made the important discovery that in parts of the distribution area of *Dipodomys heermanni* the small rudimentary first toe on the hind foot may be present or absent. The detection of positive evidence of intergradation in this character within a limited area between forms obviously not otherwise materially different is of special interest, in view of the remarkable constancy with which a fixed number of digits (4 or 5) on this foot is maintained in all of the species throughout the remainder of the wide range of the subfamily from the Valley of Mexico to southern Washington and Montana.¹ All of the species heretofore assigned to the five-toed genus *Perodipus* are therefore transferred to the genus *Dipodomys*. No reason is noted for the omission of the genus *Microdipodops*, currently regarded as a true kangaroo rat and represented in California by one species, the inclusion of which would have completed the treatment of the subfamily within the state.

¹ This condition seems somewhat analogous to that obtaining in certain squirrels, and in bats of the genera *Artibeus* and *Myotis*. The number of premolars constant in most of the included species is variable, owing to obsolescence in several, and the tooth formula therefore becomes unreliable as a generic character.

The apparent effect of climate upon the color and texture of the pelage in kangaroo rats is pointed out, closely paralleling the findings of revisers of other groups of rodents with geographic ranges embracing both the humid Pacific coast region and the arid interior. Examples of nearly parallel conditions are found in the wood rats—*Neotoma intermedia intermedia* of the western slope of the mountains, and *Neotoma intermedia desertorum* of southeastern California; and *Neotoma cinerea cinerea* typical of the Great Basin and its darker coastal counterparts *Neotoma cinerea occidentalis* and *Neotoma cinerea fusca*, and in others which may be readily cited.

Consideration of habitats, says the author, "in connection with size of ear brings out unmistakably the correlation of small pinna with open type of habitat, and in the other direction, of large pinna with a chaparral type of habitat. The same tendencies are to be observed in *Peromyscus* and *Perognathus*." While this may appear to be true in some of the California forms of these genera, it should be noted that the kangaroo rats with the largest and the smallest ears, *Dipodomys elephantinus* and *Dipodomys microps*, are assigned habitats as species wholly within chaparral, and more open types of country, respectively. The large-eared California pocket mouse, *Perognathus femoralis*, which the author may have in mind, is another chaparral-loving species with a very restricted known range. Some species of *Peromyscus* and of mammals in general inhabiting open types of country have very large ears. Admitting that certain large-eared species of kangaroo rats are associated in California with more brushy habitats than are usual in the general group, such generalizations would seem better based upon studies of more widely ranging species subdividing into geographic races and inhabiting cover of varying density.

In the discussion of distributional considerations the conclusion is reached that "as regards the species and subspecies of kangaroo rats in California, humidity is of minor importance as a barrier to extension of range as compared with unfavorable temperature and bodies or streams of water." The probable evolution of ranges is traced. Owing to the aversion of *Dipodomys* for water, continuous bodies of this element are regarded as effective barriers, but *Dipodomys deserti* and *Dipodomys merriami* occur on both sides of the lower Colorado River where shifting river channels transferring tracts of inhabited bottom land from one side to the other have doubtless given access to the opposite side. The transference of individuals, postulated by the author, would be especially likely to occur during such extensive changes in the course of the stream as took place fifteen years ago, when through the agency of man in cutting a narrow irrigation ditch, the great river was unintentionally turned into Salton Sea whence it was redirected with the greatest difficulty at the end of about a year; and the course taken by the main stream since this diversion is in places many miles west of that formerly followed.

In the formal treatment of species there are no generalized accounts of species as aggregations of subspecies, the author passing directly to a consideration of the component parts. The first species receiving attention is *Dipodomys heermanni*, and in treating its parts, instead of following a common custom among revisers of taking up first the typical subspecies, he begins with the widely ranging northern form, *Dipodomys h. californicus*, and proceeds southward, the typical form being third in the series. On reaching *Dipodomys agilis*, however, the typical

form is the first treated. The accounts include the principal synonymy, a "diagnosis," discussion of relationships, and full paragraphs under several other headings—the type locality and distribution, together with localities and numbers of specimens examined, being placed at the end. Measurements, including "ear from crown," when available, are given under each species, and in many instances the weights in grams, a valuable feature.

In regard to methods of measuring the author states that total length given "is the distance (with body and tail straightened out) from the tip of the nose to the tip of the last caudal vertebra, taken usually after skinning. If this measurement is taken in kangaroo rats before skinning, there is a chance of error because the skin sometimes slips backward some millimeters free from the actual tip of the vertebral series. Tail vertebrae is length of tail alone, from a point on upper side at base where tail can be bent at right angles to back, to tip (as just designated)." It seems to the reviewer that such a method of measuring specimens is an attempt to attain a degree of accuracy impracticable in general work. The most valuable field measurements, on the whole, are those taken by as nearly standardized methods as possible adopted by preparators in general, because these will be fairly comparable, while variations from the general standard may be misleading in application without the constant repetition of explanations. Measurements taken by different collectors, whether before or after skinning, vary with the tension exerted or with other individual peculiarities of method, and they vary, moreover, with the degree of relaxation of the body of the animal. Tables of measurements usually reveal considerable range of individual variation in total length and length of tail in animals of comparable age, and the average is obviously governed by the relative number of large or small examples chosen. These measurements must therefore usually be regarded as approximations only, which for most practical purposes should be taken before skinning, the body and tail being carefully straightened or extended to the natural limit, but not stretched.

The taxonomic treatment of a group, especially the number of forms recognized, their status as species or subspecies, and the distribution area assigned to each is likely to vary always with the varying standards set up by different workers. Perhaps no two would arrive at exactly the same conclusions. Local variants are of great interest to the close student of speciation and geographic distribution, and the current tendency is toward greater refinement in the process of "splitting," in such classes as mammals and birds at least, until the forms, if accepted, become so numerous and their ranges so restricted that the determination of new accessions of specimens is accomplished only with the greatest difficulty. The tendency to set up an excessive number of local forms is apt to be marked in faunal papers, in which the irregular, minor geographic variations presented by many widely ranging species are appraised at more than their true value. The reviser of the genus has the advantage of the wider viewpoint of the group as a whole.

In so diversified a region as California the desirability and practical utility of recognizing a considerable number of well-marked geographic races of kangaroo rats, some of which have very restricted ranges, is freely granted. But in the opinion of the reviewer the author in some of his conclusions accords undue importance to characters ascribed to certain forms, examples of some of which are cited. "*Dipodomys levipes*," originally described as a subspecies of "*Perodipus microps*,"

is elevated to full specific rank, although it "agrees with *microps* in important features of the cranium" and the "two species are similar in their rather dark type of coloration, as well as in most other external features." The differential characters mentioned are the larger size of *levipes* and details subject to considerable variation. The author is usually careful and generally accurate in his descriptions, but the statement that the mastoid bullæ in *levipes* are "fully twice the volume of those in *microps*" is inexact. This is a very variable character, as shown by the examination of paratypes of the two. The mastoid bullæ of the larger examples of *microps* closely approach or about equal those of the smaller examples of *levipes*. Probably a study of the complete range of the *levipes* type of animal across Nevada to Utah and northward to Oregon would have led the author to adopt their original status as subspecies, not very strongly marked at best.

The "Heermanni Group" is made to include four distinct species, *Dipodomys panamintinus*, *D. leucogenys*, *D. mohavensis*, and *D. stephensi*, with very limited, contiguous, or only slightly separated ranges in a region of general physiographic conformity, mainly the desert basal slopes of the mountains in southeastern California. These all agree in the possession of a salient character indicating very close relationship, the decided expansion of the maxillary arches, which at once distinguishes them from externally similar species of the genus which frequently occur in the same localities. The forms "*mohavensis*" and "*leucogenys*," described as new species, vary considerably, but specimens from the type localities are slightly paler than topotypes of *panamintinus* and present slight cranial differences, mainly size, the kind of characters we learn by analogy to regard as of not more than subspecific value. Their combined ranges half encircle that of *panamintinus*, and other geographical considerations indicate the expediency of reducing them to subspecies, or reuniting all under a single name. In cranial details *D. stephensi* presents a rather slight departure from the *panamintinus-leucogenys-mohavensis* type in that the mastoid bullæ are decidedly more inflated and there is a correlated reduction in width of the supraoccipital and interparietal, a condition not uncommon elsewhere in the genus. This form stands somewhat apart and should, perhaps for the present, be accorded specific rank, but as the characters are those usually found to be of subspecific value, intergradation may reasonably be expected.

Two subspecies, *D. nitratoides nitratoides* and *D. n. brevinasus* are assigned to very limited ranges known to be broadly confluent in the bottom of the southern end of the San Joaquin Valley, an area presenting little diversity in faunal complexion. The characters pointed out are variable and these forms are not regarded by the reviewer as satisfactorily separable. Other cases might be mentioned, but these among the more extreme examples are indicative of the general method of treatment.

While Doctor Grinnell may not be followed in all of his conclusions concerning speciation, the severest criticism being that this part of the work is over-done, he has succeeded admirably in the main purpose as announced by him at the outset; but the degree of correlation between speciation and geography and environment can be satisfactorily ascertained without the recognition of an unwieldy number of forms. His elucidation of some complicated relationships will greatly facilitate the revision of the genus *Dipodomys* as a whole.

—E. A. Goldman.